Measurement of AWACS Team Performance in Distributed Mission Scenarios

Linda R. Elliott
AFRL/HEAS
Warfighter Research Training Division
Air Force Research Laboratory
2504 Gillingham Dr., Suite 25
Brooks AFB, TX 78235-5104
Voice: 210/536-8132 DSN: 240-8132
linda.elliott@afrlars.brooks.af.mil

Rebecca Cardenas
NTI, Inc.
P.O. Box 35482
Brooks AFB, TX 78235-5104
Voice: 210/532-5723 DSN: 240-3522
rebecca.cardenas@afrlars.brooks.af.mil

Samuel G. Schiflett
AFRL/HEAS
Warfighter Research Training Division
Air Force Research Laboratory
2504 Gillingham Dr., Suite 25
Brooks AFB, TX 78235-5104
Voice: 210/536-8139 DSN: 240-8139
sam.schiflett@afrlars.brooks.af.mil

Abstract

Distributed Mission Training (DMT) enables participants to perform within a virtual battlespace created through networking of several high-fidelity simulations. In a recent exercise, *ROADRUNNER '98*, several agencies interacted to create several battlespace missions in which "friendly" fighter aircraft and command and control crewmembers participated as trainees, while supporting roles and enemy forces were either played by operational personnel (virtual players) or created by intelligent agent technology (constructed forces). Thus, trainees participated in complex demanding war scenarios without the usual constraints of cost, safety, and security normally associated with live-fire training. *ROADRUNNER '98* was sponsored by the Air Force Modeling and Simulation Office (USAF/XOC) with the Air Force Research Laboratory, Human Effectiveness Directorate's Warfighter Training Research Division (AFRL/HEA) serving as program managers and the Theater Command and Control Simulation Facility (TACCSF) as systems integrators. Extensive support was received from the Training Office at Air Combat Command's Deputy for Operations (ACC/DOT), the Air Force Information Warfare Center's Advanced Combat Simulations Division (AFIWC/SAM), the Airborne Warning and Control Systems (AWACS) training office at the 522nd Air Control Wing, the 107th Air Control Squadron

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1999		**00-00-1999 to 00-00-1999**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Measurement of AWACS Team Performance in Distributed Mission Scenarios	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air Force Research Laboratory,AFRL/HEAS,2504 Gillingham Drive Suite 25,Brooks AFB,TX,78235-5104**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**		**17**	

(ACS) of the Iowa Air National Guard (IANG), and the Naval Air Warfare Center's Training Systems Division (NAWC-TSD). The warfighters who participated in *ROADRUNNER '98* were operational pilots, Weapons Directors (WDs), and Air Surveillance Technicians (ASTs) from the 522nd ACW, Tinker AFB, OK, 27th Fighter Wing, Cannon AFB, NM, The 185th and 132nd Fighter Wings of the IANG, 33rd Fighter Wing, Eglin AFB, FL, and from the United States Air Force in Europe (USAFE).

This paper describes the process by which C3 teamwork dimensions were identified, measures formulated, and the rating instrument refined. Measures of AWACS team performance were developed based on previously collected cognitive task analysis data and refined through the use of focal groups comprised of operational AWACS WDs or WD Instructors.

TABLE OF CONTENTS

1. Distributed Mission Training: Background

Distributed simulations have become an increasingly essential aspect of operational military training. As both training and defense budgets shrink, ways of reducing the number of flight hours and yet maintaining optimal levels of expeditionary force readiness are sought. Distributed Mission Training (DMT) is looked upon as a way that will allow warfighters to train in a manner consistent with Air Force Doctrine 60: *Train like you fight, fight like you train.* Previous constraints (e.g., safety, flying status, flying hours, aircraft and environmental factors) have hampered training efforts from following this philosophy to its fullest capacity. DMT addresses these constraints and allows the warfighters of our nation to perform crucial training missions with maximum proficiency and safety, at lower cost. General Fogleman, Chief of Staff Air Force, stated on 29 Jan 1996:

> *I am convinced modeling and simulation technologies available today will enable us to significantly change the way we train in the future. We are at a crossroads where simulator technology today will be critical in the success of our effective use of follow-on weapon systems …. We need to take a hard look at how this technology will change our training philosophy as well as how we develop future weapon systems.*

DMT is focused within a synthetic warfighting environment that grants a multitude of advantages for more accurate observation and assessment in areas that were previously difficult to research. Performance can be modeled within and across individuals, teams, squadrons, and complex functions. Linkages among diverse interdependent units can be identified and modeled to achieve greater efficiency. This intensive modeling of performance within a complex system enables a more precise assessment of the impact of interventions, such as training technology, cause and effect relationships, and changes in the distribution and display of information.

DMT offers flexibility that stretches worldwide by linking participants across network lines, allowing individual warfighter training to occur concurrently in simulators whose presentation of a commonly flown mission occurs in real-time. This capability supplements cockpit flight hours with a synthetic reproduction of a complete and complex warfighting environment that combines realistic scenarios with simulated operational systems. The focal point of this paper is the Airborne Warning and Control Systems (AWACS) segment of a Distributed Mission Training demonstration (*ROADRUNNER '98*). This exercise tied AWACS weapons directors from Tinker AFB, OK, F-16 aviators from AFRL, AZ, F-15 aviators out of Kirkland AFB, NM, and an A-10 aviator from AFRL, AZ together for one week of DMT training.

2. USAF AWACS Teams

All command and control teams share some common task and performance characteristics. These teams perform in highly interdependent roles, tracking and coordinating some type of tactical action, in a manner consistent with overall strategic goals and procedures, for a defined sector of air and/or land space over a sustained period of time.

The AWACS team serves within this team definition to augment the need for airborne surveillance and command, control, and communications functions for tactical and air defense forces. This provides the means to detect, identify, track, and intercept airborne threats. The aircraft's god's-eye capability offers an altitude-independent 360° view of more than 200 miles over both land and water. There are five mission crew categories related to the function of the AWACS crew: the Mission Crew Commander (MCC), Senior Director (SD), Weapons Director (WD), Air Surveillance Officer (ASO), and Air Surveillance Technician (AST). AWACS teams typically work in teams of two to four crewmembers as part of the airborne command and control group located within E-3 Sentry aircraft.

The *ROADRUNNER '98* exercise focused primarily on the integration of multiple warfighter-in-the-loop training simulators, combining them with synthetic forces to form a virtual battlespace to conduct several assorted combat-oriented, tactical training exercises. The overall goal of this effort was to compare initial team performance with subsequent performance after participation, and give the participants the opportunity to critique both the systems and the concept of training (Parton, 1998). Each scenario was based on intelligence briefings and air tasking order (ATO), and each fighter and AWACS team planned, coordinated, and briefed their mission. The combined teams flew the mission in their respective simulators with a trusted agent monitoring and evaluating their performances. The teams and instructors participated in an after-action review aided by a mission playback system that assisted during the debriefing process. Each team participated in 7 separate missions over the course of one week.

3. Development of Team Observer Form

The AWACS crew coordinates communications received from a number of sources, such as other WDs, the SD, air surveillance technicians (ASTs), electronic combat officers (ECOs), intelligence operations, base operations, and friendly pilots. To accomplish this, they must exchange, interpret and effectively weight information and optimize resource allocation decisions across team members, over time, and under stress and fatigue. These decisions regard shared resources, such as surface-to-air missile sites and various combat, reconnaissance, refueling, and search and rescue aircraft. Relevant information must be distributed to appropriate personnel and updated over time, in dynamic conditions which may require shift changes in personnel. Information is often verbal, and may be missing, degraded, passed along from unfamiliar sources, or misinterpreted by others. In addition, information is often communicated/interpreted by individuals with only partially overlapping awareness of the battlespace. For the *ROADRUNNER '98* study, assessment of AWACS team of performance was based on SME ratings of several dimensions of AWACS team performance. These dimensions were generated based on cognitive task analyses, followed with focus groups comprised of experienced AWACS instructors. These focus groups served to refine the rating form, and included the SMEs who actually participated as *ROADRUNNER '98* trusted agents/evaluators.

Cognitive Task Analyses

Assessment of individual and team performance in realistic combat environments requires (a) the capability to produce complex and dynamic scenarios, (b) identification of constructs that represent important individual and team skills, and (c) identification and/or development of

construct measures. In addition, each scenario must have identified quantitative criteria of mission success. Cognitive task analyses informed and influenced the development of scenario characteristics and the identification of primary performance constructs and measures.

Several cognitive task analyses have been performed on AWACS operational personnel. First, analyses have been performed with regard to AWACS individual tasks, with a primary focus on display enhancements (Klinger et al., 1993). In addition, Fahey and associates (Fahey et al., in review) investigated the AWACS task domain with a special focus on AWACS team tasks, utilizing cognitive task analysis and critical incident techniques for data elicitation. Their report provides a comprehensive description of the AWACS task, and the general finding that critical incident technique was quite useful for the description of AWACS teamwork.

In addition, a follow-up analysis of AWACS tasks, with a primary focus on team functions has been articulated and initiated (MacMillan et al., 1998). This was a preliminary investigation, to test a team-based approach to cognitive task analysis. Results were very informative, supporting frameworks and constructs within an information-requirements approach to task descriptions.

4. Articulation of AWACS Teamwork

One core dimension that characterizes teams in general is the type and degree of interdependence among team members (Saavedra et al., 1993; Salas, et al., 1992). Teams are distinguished from groups in general by a common purpose or goal, performed by interdependent team members (Salas et al., 1992). From this definition we derived a core definition of teamwork: *The fundamental function of teamwork is the effective managing of interdependencies to accomplish a team goal.* From this core definition we identified 6 dimensions of team interdependence (Elliott & Schiflett, in review).

Discussion with focal groups comprised of AWACS subject matter experts led to refinement of our preliminary team task taxonomy, as applied to AWACS team training and performance evaluation. Prior to the *ROADRUNNER '98* exercise, we interviewed 38 expert AWACS weapons directors. These groups reviewed the proposed scenarios and assisted in the evaluation and refinement of an instructor/observer rating form (see Appendix). Review of the initial taxonomy, which was generated to classify teams in general, led to the identification of four teamwork functions which are specific to AWACS teamwork: (a) mission planning, (b) communication content/timing, (c) adherence to communication protocol, and (d) supporting behavior.

4.1 *Mission planning: formulation of "contracts"*

AWACS performance can be divided into three phases: premission planning, task execution, and debriefing (discussion after task execution). Mission planning affects AWACS teamwork by establishing roles, responsibilities, and contingency plans. As discussed by Fahey et al. (1998) and Macmillan et al. (1998) AWACS weapons directors explicate roles, responsibilities, and strategies to manage team member interdependencies through the establishment of "contracts". These contracts are made among AWACS team members (internal contracts), and to the "external" team (i.e., pilots of friendly assets).

4.2 *Communication: adherence to protocol*

AWACS weapons director tasks are based predominately on the exchange of verbal information. Communications are heavily standardized in terms of content (jargon) and process. This aspect of communication effectiveness refers to the degree to which individual follow guidelines for communication exchange. In addition to proper jargon and syntax, communications must be clear, concise, and correct.

4.3 *Communication to support situation awareness*

Communications may be clear, concise, correct, and delivered according to proper protocol, and still be superfluous. The maintenance of situation awareness also requires that pertinent information be exchanged to the right person, at the right time. In such a communication-rich environment, too much communication can impede performance, when unnecessary information "steps over" other, more urgent communication. Indeed, part of the proper timing of AWACS communications to pilots involves knowledge of when to keep quiet.

4.4 *Supporting behavior*

While it would seem apparent that this aspect is most clearly representative of teamwork, the conceptualization of supporting behavior among AWACS weapons directors was more difficult to validate through subject matter experts. While there was no doubt that AWACS teammembers do support each other, the argument was made that most of the support is in the form of communication exchange. AWACS teammembers support each other primarily through updates and reminders of salient information. At the same time, they can also transfer resources (responsibilities) and confer on decisions/actions, therefore it was decided to keep this construct as an independent aspect of AWACS teamwork.

5. Rating Instrument

Once the dimensions of AWACS teamwork performance were refined by the SME focus groups, the rating instrument was tailored to capture these dimensions across three phases of performance: (a) premission briefing, (b) mission performance, and (c) mission debriefing. Ratings were based on a 4-point scale, using traditional rating assessment categories. The rating categories used are based on the same categories of performance used in AWACS WD training.

AWACS Team Observer Form
Rating and Definition of Performance Criteria

1. **No Ability or Knowledge**. Task Failure
2. **Lacks Proficiency.** (Coordination, Communication, Cohesion).
3. **Uncorrected errors**. Degraded Mission Outcome or Endangered Friendly Forces.
4. **Limited Proficiency**. Recognizes and corrects errors with team recovery. Mission Degraded.
5. **Proficient**. No mission impacting errors. Team reacts correctly in current situations.
6. **Highly Proficient**. Prevents errors. Team anticipates future situations. Plans ahead.

NA = Not Applicable **NO = Not Observed** **NP = Not Performed**

Table 1: Rating Scale for Dimensions of Performance

WDs were rated on the following during the Phase I portion of their performance evaluation:

(a) Development of Mission Aids,
(b) Formulation of contracts internal to the AWACS team,
(c) Formulation of contracts external to the AWACS team, and
(d) Prebrief of pilots.

These aspects were identified during the subject matter expert focal interviews as critical to successful premission planning and team performance. *The development of mission aids* included the generation, refinement, and review of the communications worksheet (which specifies who talks to whom on which channel), the fighter flow sheet, the chart, and the fact sheet, all of which describes and/or specifies procedures to enhance awareness and coordination. *Formulation of internal contracts* refers to the agreements made among the WDs as to their roles and responsibilities. Communication tasks and console assignments are set, specific mission objectives are discussed, and functional responsibilities and contingency plans are specified and assigned. *Formulation of external contracts* refers to the procedures executed between the WDs and others (pilots) with regard to roles and responsibilities, such as those regarding objectives, strategies, and communications. These contracts are then discussed within the briefing session (*Pre-brief Pilots)* by the lead WD with the lead pilot, along with issues such as the rules of engagement (ROE) and Air Tasking Order (ATO) compliance.

Phase II performance (during mission execution) was assessed by ratings regarding (a) communication in accordance with 3-1 and Unit Standards, (b) communications in support of situation awareness and the "big picture", and (c) mission execution. Communications are assessed in terms of adherence to established protocol, which strives to maximize aspects of clarity, brevity, and accuracy—communications that are clear, concise, and correct. This includes communications among WDS and also their communications to others (rated separately). In addition, communications are also rated with regard to relevance and timeliness—is the information what was needed to maintain team situation awareness—was the right information "pushed" to the right person at the right time? Mission execution was assessed

through consideration of ATO execution, contract execution (formulated during premission briefing), and adaptive replanning (flexibility, problem-solving, contingency generation as needed).

Phase III (mission debriefing) performance was assessed through ratings of (a) reconstruction of the engagement, (b) evaluation of team objectives, (c) review of equipment issues, (d) review of team mission execution, and (e) review of information exchange. Reconstruction of the engagement was assessed through consideration of the process of reviewing the recordings and the identification of conflicts and/or problems. Objectives were reviewed in light of mission support and execution of contracts. Equipment issues included communication, console assignments, and any failures/alibis. Team mission execution was assessed through consideration of priority objectives, training objectives, and any failures/alibis. Information exchange was considered with regard to internal and also external communications. Communications should have supported overall situation awareness, and lessons learned should be identified during the mission debriefing.

Each team was rated on various dimensions of performance across three phases of performance, for each mission. They were assessed for performance in Phase I (premission briefing), Phase II (mission execution), and Phase III (mission debriefing). Measures and variable names are as follows:

5.1 *Premission Briefing*

Development/Use of Mission Aids (MSNAID_1): Effective use of appropriate mission planning aids, such as communications worksheets, charts, fighter flow sheet, and fact sheet.

Negotiation of contracts internal to AWACS team (ICONTR_1): Effective discussion and coordination of interdependencies among AWACS WDs and AST, with regard to communications, console setup, mission tasks (who is primary/assist; coordination with AST), and mission objectives.

Negotiation of contracts external to AWACS team (ECONTR_1): Effective discussion and coordination with pilots, with regard to communications, mission tasks, and objectives.

Pre-brief with Pilots (PREVI_1). Effective discussion and coordination with pilots, with regard to objectives, standards (Wing and Squadron), Air Tasking Order compliance, and Rules of Engagement.

Overall for Premission Briefing (PHASEI). Average of above. Measures.

5.2 *Mission Execution*

Communications in Accordance with standards, internal to AWACS Teams (COMMI_2): Extent of compliance to standard communication protocols, regarding continuum of control, Land Unit Standards, C-3 (Clear, Concise, Correct), and use of correct call signs.

Communications in accordance with standards, external to AWACS Teams(COMME_2): Extent of compliance to standard communication protocols, regarding continuum of control, Land Unit Standards, C-3 (Clear, Concise, Correct), and use of correct call signs.

Maintenance of Situational Awareness and Big Picture in communications internal to AWACS Team(SA_PI_2): Content and timing of communications (as opposed to process).

Maintenance of Situational Awareness and Big Picture in communications external to AWACS Team(SA_PE_2): Content and timing of communications (as opposed to process).

Mission Execution internal to AWACS Team (MSNEXI_2): Performance with regard to execution of Air Tasking Order, Contract execution, and adaptive replanning (flexibility, problem solving, and contingency).

Mission Execution external to AWACS Team (MSNEXE_2): Performance with regard to execution of Air Tasking Order, Contract execution, and adaptive replanning (flexibility, problem solving, and contingency).

Overall mission execution (PHASEII): average of six measures above.

5.3 *Team Debrief*

Reconstruction of engagement- internal to AWACS Team (RECENG_3): Effectiveness of review of engagement through review of recording and identification/discussion of conflicts/problems.

Evaluation of Performance with regard to objectives internal to AWACS Team (EVALON_3): Effectiveness of review of performance with regard to mission support and contracts.

Equipment- internal to AWACS Team (EQUIP_3): effective identification and discussion of issues with regard to equipment, such as communication and checkout, console assignments and check-outs, and failures/alibis.

Discussion of Team Mission Execution external to AWACS Team (TMISEX_3). Identification and discussion of issues with regard to support of priority objectives, WD/AST training objectives, and failures/alibis.

Information exchange Internal to AWACS Team (INFEXI_3). Effective discussion of information exchange among AWACS team members, with regard to maintenance of shared mental picture (situation awareness) and lessons learned.

Information exchange external to AWACS Team (INFEXE_3). Effective discussion of information exchange among AWACS team members and others, with regard to maintenance of shared mental picture (situation awareness) and lessons learned.

Overall Mission Debriefing (PHASEIII). Average of six measures above.

Overall Mission Performance (OVERALL). Average of all measures.

6. Results

Descriptive Statistics: Average ratings across teams (3), scenarios (7), and raters (2 per team and scenario for Phase II). Results indicate variance in distribution in ratings, with utilization of the entire rating scale, for most measures.

Premission Planning:		N	Minimum	Maximum	Mean	Std. Deviation
MSNAID_1	25	2.00	4.00	3.0800	.4933	
ICONTR_1	25	2.00	4.00	2.9600	.6758	
ECONTR_1	24	1.50	4.00	2.8125	.6726	
PREVI_1	24	1.00	4.00	2.8542	.6833	
PHASE I	**25**	**1.88**	**3.75**	**2.9200**	**.4703**	
Task Execution:						
COMMI_2	42	1.00	4.00	2.9881	.7690	
COMME_2	42	1.00	4.00	2.7143	.7741	
SA_PI_2	42	1.00	4.00	2.9524	.7949	
SA_PE_2	42	1.00	4.00	2.6905	.8762	
MSNEXI_2	42	1.00	4.00	3.0000	.7730	
MSNEXE_2	41	1.00	4.00	2.6951	.9413	
PHASE II	**42**	**1.33**	**4.00**	**2.8421**	**.7301**	
Debrief:						
RECENG_3	24	2.00	4.00	3.1250	.6124	
EVALON_3	24	2.00	4.00	3.0417	.7929	
EQUIP_3	26	2.00	4.00	3.1154	.4961	
TMISEX_3	24	1.00	4.00	3.0833	.8805	
INFEXI_3	25	1.00	4.00	3.0400	.8406	
INFEXE_3	24	1.00	4.00	2.9792	.8140	
PHASE III	**27**	**1.50**	**4.00**	**3.0562**	**.5970**	
OVERALL	**22**	**1.94**	**3.69**	**2.8699**	**.4705**	
Valid N (listwise)	16					

6.1 *Differences in performance attributable to differences among raters*.

ANOVA analyses indicated no significant differences among raters with regard to any of the measures (See Appendix for descriptives and ANOVA results). In addition, regression analyses based on the consideration of trusted agents, teams, and scenarios indicate that the variance attributable to differences among trusted agents was not significant.

6.2 *Relative impact of three sources of variance (trusted agents, teams, and scenarios).*

There were three primary sources of variance: that attributable to raters (which should be minimized), to differences among teams (not of primary interest here), and to the training exercise itself (differences among the 7 scenarios was predicted to demonstrate improvement over time). Multiple regression analyses were performed, first on the model composed of trusted agents, teams and scenarios. This model predicted 73% of the total variance in ratings. In addition, the consideration of trusted agents did not add to the prediction of ratings, thus indicating reliability of measures with regard to raters. The analyses were then run using teams and scenarios as predictors, and the model still predicted 73% of the total variance in ratings.

Model Summary: Predictors: (Constant), SCENARIO, TEAM, TRUSTEDA

Dependent Variable: OVERALL

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.859	.738	.694	.2603

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	3.429	3	1.143	16.867	.000
Residual	1.220	18	6.776E-02		
Total	4.648	21			

Coefficients

	Coef-B	S.Err	Beta	t	Sig.
1 (Constant)	2.591	.221		11.750	.000
TRUSTEDA	-4.394E-02	.045	-.117	-.969	.345
TEAM	-.170	.070	-.294	-2.436	.025
SCENARIO	.177	.027	.792	6.557	.000

a Dependent Variable: OVERALL

These data indicate that participation in the training exercise had a significant effect on performance, across all teams, and for most measures of performance across the three phases of performance. Results are described in further detail for the effects due to differences among teams, and differences across scenarios.

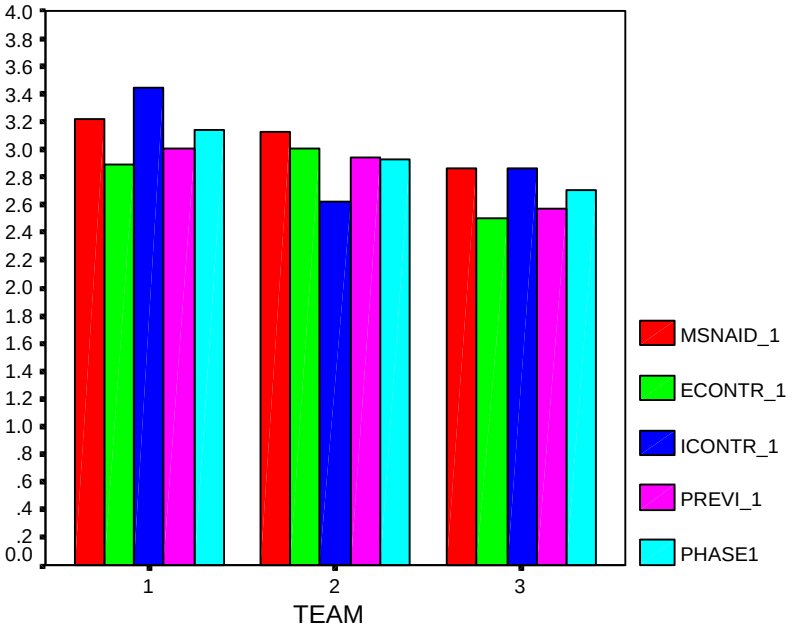
6.3 *Differences in performance attributable to differences among teams.*

Data demonstrate the advantage in careful construction of performance constructs. The overall measure of performance was based on the mean of all measures; ANOVA results did not indicate significant differences among teams. There were, however differences among teams for the measurement of one aspect (negotiation of contracts among team members) of performance during premission briefing, and for nearly all aspects of performance during mission execution. Teams did not differ significantly in performance during mission debriefing. An overall assessment of performance may be too generic to capture effects of a predictor variable.

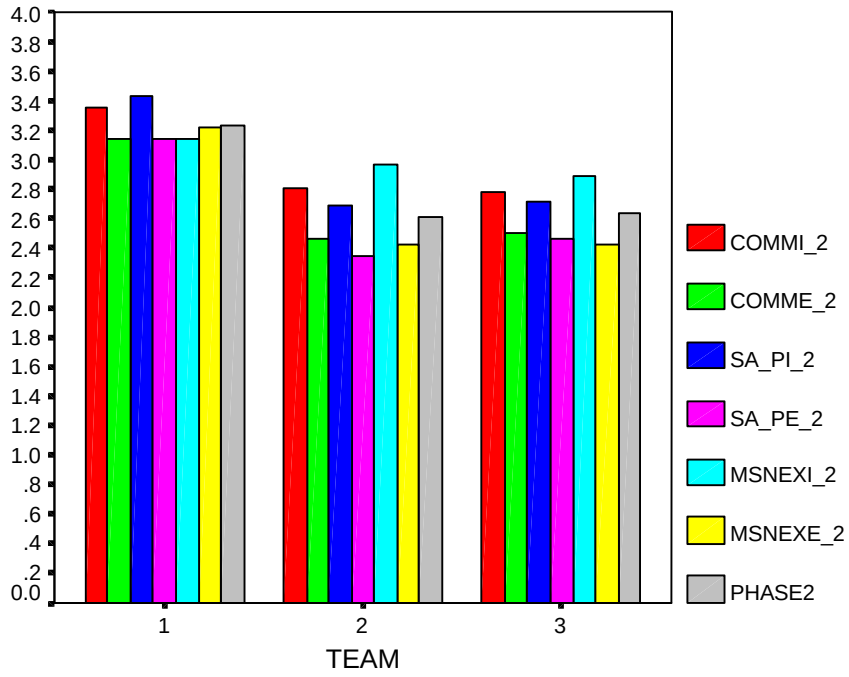
ANOVA: Significant Differences By Team, Between Groups

Variable	**Sum of Squares**	**df**	**Mn Sq**	**F**	**Sig.**
ICONTR_1	3.363	2	1.681	4.869	.018**
MSNEXE_2	5.730	2	2.865	3.665	.035**
SA_PE_2	4.298	2	2.149	3.083	.057*
SA_PI_2	4.762	2	2.381	4.392	.019**
COMME_2	3.857	2	1.929	3.631	.036**
COMMI_2	2.869	2	1.435	2.617	.086*
PHASE2	3.298	2	1.649	3.466	.041**

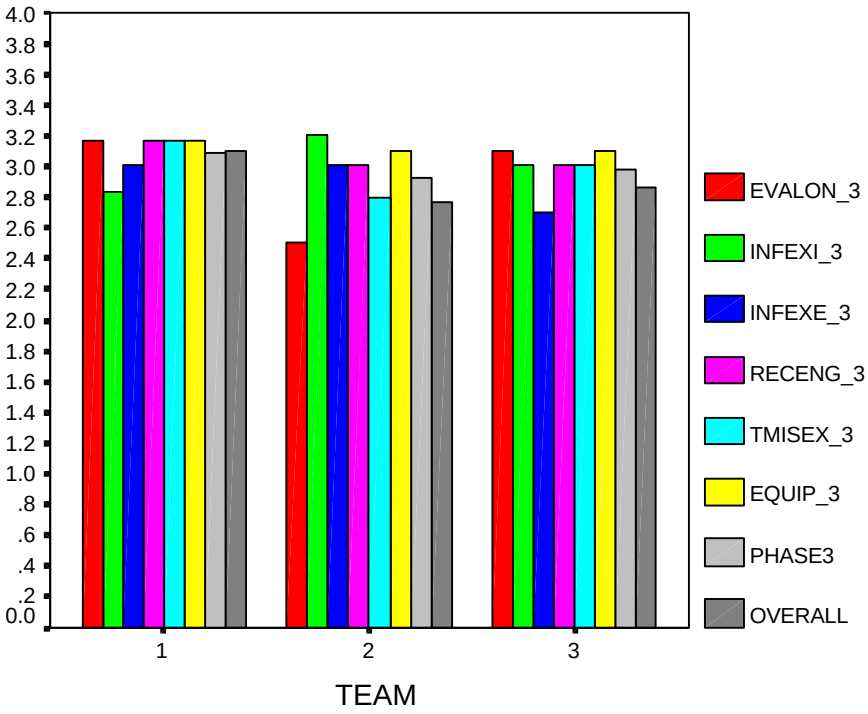
Performance Ratings for Phase I: By Team



Performance Ratings for Phase II: By Team

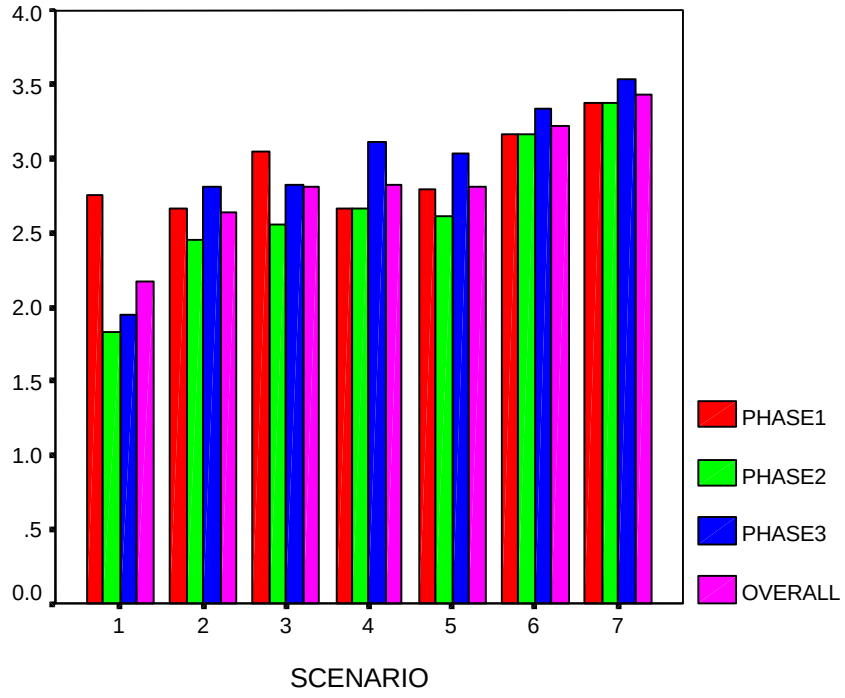


Performance Ratings for Phase III: By Team



6.4 ***Differences attributable to scenarios and experience.***

Team performance differed significantly across scenarios for many of the measures (See Appendix for descriptives and ANOVA output). Differences in measures among scenarios would capture differences due to the scenario content, as scenarios differed in mission objective and content. They would also be due to experience over time. However, Scenario 1 and Scenario 7 are very similar in content, to better ascertain the effect of experience on performance. First we describe differences across all scenarios. The following graph describes overall results of instructor ratings of AWACS team performance, for each mission session, ordered over time.



The above graph provides a succinct glimpse of trends regarding the effect of simulation participation on performance, through differences in performance from Scenario 1 and Scenario 7, by phase. Here it can be seen that variance in performance across scenarios was more attributable to performance in Phases II and III: teams were lower in performance during Phase II and III during the first scenario, and demonstrated higher improvement in these phases. At the same time, performance during Phase I (premission briefing) also improved over time.

Overall results for each team for Scenario 1 (pretest) and Scenario 7 (post-test). Team A was the highest performing team for both pre-and post scores. Improvement for this team was consistent across the three phases. In comparison, Teams B and C performed less well from the start, and particularly less well in Phase II (mission performance) and Phase III (debriefing performance). Data indicate that training needs exist for the kind of training that distributed mission training provides: improvement in team premission briefing, team coordination and team debriefing. In addition, data demonstrate the effectiveness of participation in the training exercise for the improvement of performance across all phases of each mission.

7. Discussion

Results were consistent with expectations. Simulation-driven distributed mission training were expected to add value through the experience of complexity of team-on-team interdependencies. The immersion of individuals into teams within a global mission scenario should enhance their capability of managing these interdependencies during performance. Debriefing experience is particularly valuable to AWACS crew as they often do not get the advantage of debriefing with pilots after the mission; their mission usually extends beyond the time of performance of a particular combat aircraft. The value of this experience is indicated by the increased

performance during debriefing of later mission scenarios. In addition, teams improved on most aspects of performance throughout mission planning and execution.

Data demonstrate the advantage of careful construction of performance constructs. The overall measure of performance was based on the mean of all measures; ANOVA results did not indicate significant differences among teams. There were, however differences among teams for the measurement of one aspect (negotiation of contracts among team members) of performance during premission briefing, and for nearly all aspects of performance during mission execution. Teams did not differ significantly in performance during mission debriefing. An overall assessment of performance may be too generic to capture effects of a predictor variable.

8. Summary

The following quote very aptly captures the essence of the *ROADRUNNER '98* experience:

> *The ROADRUNNER '98 concept of operations and its execution was a valuable tool in development and evolution of Distributed Mission Training (DMT). This exercise demonstrated the ability to interface multiple virtual warfighters and synthetic forces to form a virtual battlespace that can be used to conduct realistic combat-oriented training. Our goal was to compare team performance before and after DMT training and to give the participants the opportunity to critique both the systems and this concept of training. The initial comments from the AWACS crews suggest that they found DMT to be a viable and productive training tool. The technology was proven capable of providing combat-oriented training at low cost, with fewer risks, while still maintaining the security constraints associated with aviation duties. ROADRUNNER '98 has shown the potential to provide improvements in pre-planning and mission execution with emphasis in shared training exercises to provide endless training opportunities to the 21st century aviator.*
>
> *Randy L. Parton, Major, USAF*
> *Chief, Modeling and Simulation*

The approach taken during the evolution of the rating scales enabled the collection of data that significantly adds to the understanding and research of team communications, interdependencies, and training.

Post-mission questionnaires provided comments, information, and guidance that have proves helpful in the creation of continued DMT missions and research.

Participants responded to:

How mission impacted learning and training:

- *A staged 4-day war would be very beneficial.*
- *Using voice/data recording capability helps us pinpoint errors & allows a thorough debrief, enhancing the learning experience.*

Whether exercise helped meet squadron training objectives:

- *Good intro to a Red Flag exercise.*
- *Great real war training, with inexperienced … benefiting most.*

Whether exercise has the potential of meeting squadron training objectives:

- *Work the bugs and this could be a simulated Red Flag.*
- *It will definitely increase amount of learning gained from SIM.*

Suggestions for improvements:

- *Tie SIMs together with a grand order of battle, Intel, and more complete mission planning.*
- *Allow full-crew participation.*
- *Anything that can go wrong on the jet needs to be able to go wrong here.*

In addition, participants commented on the number of "lessons learned" that occur when training involves so much training in one week, and believed the non-predictability of real pilots manning the aircraft, as opposed to sim drivers, added indescribably to the realism of the mission.

The ongoing development of distributed mission training will allow USAF to move into the next century as a cohesive, well trained warfighting unit. The technology and research providing the foundation for this capability will allow for a more efficient, cost-effective, and objective means of training that has only begun to make its impact on the military concept of warfighter readiness.

9. References

[Elliott, in review] Elliott, L.R. & Schiflett, S. (in review). Development of Synthetic Team Training Environments: Application to USAF Command and Control Aircrews. To appear in H. O'Neil & D. Andrews (Eds.) *Aircrew Training: Methods, Technologies, and Assessment.*

[Fahey, in review] Fahey, R.P., Rowe, A., Dunlap, K. and DeBoom, D.(in review). *Synthetic Task Design (1): Preliminary Cognitive Task Analysis of AWACS Weapons Director Teams*. Technical Report. Brooks AFB, TX: Armstrong Laboratory.

[Fogleman, 1996] Fogleman, General. *Chief of Staff Air Force: Perspective*. 29 Jan 96.

[Klinger, 1993] Klinger, D.W., Andriole, S.J., Militello, L.G., Adelnam, L., Klein, G. & Gomes, M.E. *Designing for performance: A cognitive systems engineering approach to modifying an AWACS human-computer interface.* AL/CF-TR-1993-0093. Wright-Patterson AFB, OH: Armstrong Laboratory, 1993.

[MacMillan, 1998] MacMillan, J., Serfaty, D., Young, P., Klinger, D., Thordsen, M., Cohen, M., Freeman, J. & Elliott, L.R. *A system to enhance team decisionmaking performance: Phase I Final Report*. Brooks AFB, TX: AFRL Warfighter Training Research Division. 1998.

[Parton, 1998] Parton, Randy. *ROADRUNNER '98 After Action Report*. 7 Aug 98.

[Saavedra, 1993] Saavedra, R., Earley, P.C & Van Dyne, L. Complex interdependence in task-performing groups. *Journal of Applied Psychology*, 78 (1), 61-72, 1993.

[Salas, 1992] Salas, E., Dickinson, T., Converse, S. & Tannenbaum, S. Toward and understanding of team performance and training. In R. Swezey & E. Salas (Eds.) *Teams: Their training and performance*. Norwood NJ: Ablex Publishing Corp. 1992.